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FOCUS on Field Epidemiology

Introduction to Forensic Epidemiology

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Jane definitely needs coffee to sort through the mail coming to the television news program where she works. She is well educated, but the best job she could get at the network includes going through the mail. Sigh! There are pieces of fan mail, news requests, even credit card offers. Hmm… a free coffee-maker with the Platinum 6000 card… maybe she'll keep that one for herself. She rips into one piece of mail after another and sorts them into "keep" and "throw-away" piles. Suddenly, one envelope sheds a mysterious powder onto her desk. Jane feels her panic rise. Shaking, she backs away from the desk and yells, "Can somebody call an epidemiologist?!"

OK, maybe an epidemiologist wouldn't be the *first* person she called for, but as we shall see in this issue of FOCUS, epidemiology is an increasingly important part of criminal investigations.

Epidemiology is "the study of the distribution and determinants of health related states or events in populations, and the application of this study to control health problems" (1); it has been called the basic science of public health. Epidemiological methods can be used to identify groups of the population who are at highest risk for disease, to monitor population rates of exposures and diseases and to recognize and control epidemics. Epidemiology is important in numerous fields of study, including occupational health and safety, infectious diseases, cardiovascular disease, gastrointestinal disease, cancer, nutrition, injury prevention and the environment.

Epidemiological methods have been used for centuries to investigate disease occurrences. For example, epidemiology was used in the investigation of scurvy by James Lind in 1747, scrotal cancer by Percival Pott in 1775, cholera by John Snow in 1849, and pellagra by Joseph Goldberger around 1914. More recently, epidemiology has provided evidence for the association between fluoride use and dental caries, cigarette smoking and lung cancer, tampon use and toxic shock syndrome, and HPV exposure and cervical cancer; it has also been used to investigate health risks associated with proximity to power lines, exposure to dietary supplements, and use of hormone replacement therapy.

These examples are of exposure-disease associations considered to be naturally occurring phenomena, in that these diseases were not intentionally caused in order to harm human populations. However, we have now entered a new era in public health and epidemiology that involves the investigation of health-related criminal cases such as deliberate poisonings and bioterrorist events. In order to continue protecting the public's health, agencies that may seem unlikely partners need to work closely together. Epidemiology can serve as a link between disciplines such as law, medicine, pharmacy, statistics, city planning, and emergency management services to achieve the goal of a healthy public. A discipline called forensic epidemiology is serving as the pivotal point between these disciplines.

Forensic epidemiology

Forensic epidemiology uses public health methods in a potential criminal investigation (2). The discipline originally developed to deal with the growing complexity of litigation following health-related incidents. Its primary role has been in the courtroom, providing expert witnesses trained in epidemiology to testify in cases such as toxic shock syndrome (TSS) associated with tampon use. More recently, it has also been used in field-based investigations by law enforcement officials, including the 2001 anthrax public health/ criminal investigations.

Epidemiology in the courtroom

Epidemiologists have been called upon often in the past few decades to help resolve disease-related litigation. They have served as investigative experts, consulting experts, and expert witnesses (3). For example, epidemiologists have been used to interview case-patients, to explain the scientific principles underlying a particular matter, to explain statistical principles for analyzing study outcomes, and to present data collected on the exposure and outcome under scrutiny (3). Several cases in which epidemiology has been used in the courtroom are briefly summarized in Table 1.

The use of epidemiology in the courtroom is not, however, always accepted. Science and law involve different processes and have different goals and these differences are highlighted in the courtroom, where unequivocal evidence is needed to win a case. Science is an ever-changing process, open to peer review and revisions, and often new studies are ongoing to provide better and more accurate conclusions (3). Law is final and it is sometimes difficult to convince the court that the scientific evidence presented in the case is now and will remain 'truth.' Further, epidemiology is the study of disease in populations, not individuals (3). However, the law is concerned with alleged harm to a specific individual. Finally, because many diseases have long periods of development, it is often difficult to prove in court that an exposure that may have occurred long ago played a significant role in disease development (3). Law requires a causal link, but epidemiology is often unable to determine that the specific exposure under question is the sole cause of the disease.

Despite these concerns, epidemiology is widely used in the courtroom to prosecute cases. In the 2001 anthrax investigations, all of the isolates tested from 17 clinical specimens and 106 environmental samples collected in Florida, Washington, DC, New Jersey, New York City, and Connecticut were indistinguishable (4), providing evidence that the cases were related. Information on the mechanisms of

Table 1: Sample cases in which forensic epidemiology has been used.

Case Study	Association investigated	Comments
Silicone breast implants	Relationship between silicone gel implants and risk of cancer and connective tissue disease	Damages were awarded although evidence was presented both for and against the association
E. coli infection	Relationship between infection and consumption of allegedly contaminated food	Public health officials can often determine the culprit food item in an outbreak investigation using epidemiologic methods
Tampon use	Association between the polyester foam and highly absorbent cellulose used in tampons and toxic shock syndrome (TSS)	Tampon manufacturers changed the absorbency levels of tampons and were required by the FDA to include package inserts about TSS
Tobacco use	Association between smoking and lung cancer	The evidence indicating an association was substantial, and damages have been awarded to smokers who have developed lung cancer

Useful resources to learn more:

- http://www.slu.edu/colleges/sph/csbei/bioterrorism/key_references/DOJ/HandbkForensic.pdf
- http://www.slu.edu/colleges/sph/csbei/bioterrorism/key_references/DOD/bwirp_npdo_dod_ceir.pdf
- http://www.bt.cdc.gov/

infection, cross-contamination, molecular typing, and any available DNA evidence may ultimately be used in the courtroom as biological and physical evidence to identify the person or persons responsible for the attack.

Field-based forensic epidemiology

Epidemiologists are also involved in criminal cases long before the litigation stage. Most public health workers will encounter forensic epidemiology in the field as investigations unfold.

Many different disciplines may participate in a field-based forensic epidemiology investigation (Table 2). Two of the biggest players in a health-related investigation for an event such as bioterrorism are public health and law enforcement officials. These two groups share the goals of protecting the public, preventing or stopping the spread of disease, identifying those responsible for a threat or attack, and safeguarding all people involved in the response and investigative phases. During an investigation, law enforcement can offer criminology expertise, forensic laboratory collaboration, and connections to national and international law enforcement agencies (5). Public health can offer expert medical and laboratory consultation and collaboration with national and international public health organizations (5).

Examples of health-related criminal cases

Today, the public is very much aware of the nation's vulnerability and the possibility of health-related criminal events. In order to prepare for possible attacks or events, a review of prior events is important. Table 3 on the following page gives a brief summary of the uses of biological agents in criminal attacks since 1970. These events illustrate the range of possible reasons for attacks and show types of investigations in which law enforcement and public health might participate together.

In addition to the criminal acts listed in Table 3, HIV-contaminated blood has also been used to infect individuals, including one child. There have also been numerous hoaxes or pretended disseminations of biological weapons, which are also crimes and take resources to investigate. Between 1998 and 2000, at least 105 anthrax hoaxes have occurred at post offices, abortion clinics, high schools, energy plants, congressional offices, and hospitals (6).

Conclusion

Forensic epidemiology has been used for many years in the courtroom, and public health and law enforcement have conducted joint investigations of many health-related criminal events. The magnitude of terrorist events occurring since September 2001 has increased our attention to these types of events. It is important to educate public health and law enforcement on the ways in which each other conducts investigations and the ways in which the disciplines can work together to secure the public's health.

Table 2: Disciplines that may become involved in a forensic epidemiology investigation

Local and state health departments	Federal Bureau of Investigation
Police and firefighters	National Guard and other military units
State bureaus of investigation	Centers for Disease Control and Prevention
Emergency management services	Federal Emergency Management Administration
Hospitals and health clinics	United States Department of Agriculture
State laboratories	Department of Homeland Security
Pharmacists	Attorney General's Office

Glossary

Epidemiology: The study of the distribution and determinants of health related states or events in populations, and the application of this study to control health problems.

Forensic epidemiology: The use of public health methods in potential criminal investigations.

Field-based forensic epidemiology: The application of public health methods in a field-based setting to investigate health-related criminal events. Field-based work usually includes both public health and law enforcement officials, among others.

Courtroom-based forensic epidemiology: The application of public health methods to resolve disease-related litigation.

Table 3: A sample of confirmed use*, probable use**, and threatened use† (with confirmed possession) of agents involved in criminal or terrorist events from 1970 to the present (adapted from Carus, 2001).

Date	Place	Agent used in event	Comments
1997*	New Zealand	Rabbit hemorrhagic disease (RHD) virus	Farmers used RHD virus as an animal control tool
1996*	Dallas, TX	*Shigella dysenteriae* type 2	Laboratory stock culture was used by a disgruntled employee to contaminate pastries of lab staff; 12 of 45 workers contracted severe diarrheal illness
1996†	England	*Yersinia enterocolitica*	An extortion attempt was directed at British dairies by threatening to contaminate milk
1990**	Scotland	Giardia	Feces containing agent were allegedly placed in water tank
1990 - 1995*	Japan	*Bacillus anthracis*, botulinum toxin, sarin	Aum Shinrikyo, a religious cult, allegedly released agents on several occasions using cars/trucks, a sprayer on a roof, and briefcases/jars in subway; only 1 attempt (with sarin) was successful in causing injury
1989**	Namibia	Cholera, Yellow fever virus	The Civilian Cooperation Bureau allegedly contaminated the water supply in a refugee camp
1985**	Mexico	Screwworm	Mexican workers allegedly spread the parasite to protect jobs in an eradication program
1984*	The Dalles, OR	*Salmonella typhimurium*	Rajneeshees, a religious cult, put the agent into salad bars at restaurants to influence voter turnout; 751 people became sick
1984†	NY	*Clostridium tetani, Clostridium botulinum*	Was intended to use to kill racehorses in an insurance fraud scheme
1978*	London	Ricin	A Bulgarian dissident was stabbed in the leg with an umbrella that had the agent on the end and died
1977 - 1980*	Norway	Curacit	A nursing home worker used the agent to kill 22 patients
1972†	Chicago, IL	*Salmonella typhi*	Teenagers plotted to infect the municipal water system
1970*	Canada	*Ascaris suum* (parasite)	A man infected 4 roommates; 2 suffered acute respiratory failure

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REFERENCES

1. Last JM, ed. *A Dictionary of Epidemiology*, 3rd Edition. New York, NY: Oxford University Press, Inc; 1995.
2. Goodman RA. Basics of Public Health/Epidemiologic Investigations for Law Enforcement. Presented at Forensic Epidemiology Training Course; November 2-5, 2002; Chapel Hill, NC.
3. Loue S. *Forensic Epidemiology: A Comprehensive Guide for Legal and Epidemiology Professionals*. Carbondale, IL; Southern Illinois University Press; 1999.
4. Jernigan DB, Raghunathan PL, Bell BP, Brechner R, et al. Investigation of bioterrorism-related Anthrax, United States, 2001: Epidemiologic findings. *Emerging Infect Dis* 2002;8:1019-1028.
5. Martinez D. Law Enforcement and Forensic Epidemiology. Presented at Forensic Epidemiology Training Course; November 2-5, 2002; Chapel Hill, NC.
6. Carus WS. Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900. Washington, DC: Center for Counterproliferation Research, National Defense University; February 2001. Available at: http://www.ndu.edu/centercounter/Full_Doc.pdf. Accessed August 8, 2005.

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